Detecting the Geminids Using Radio Waves

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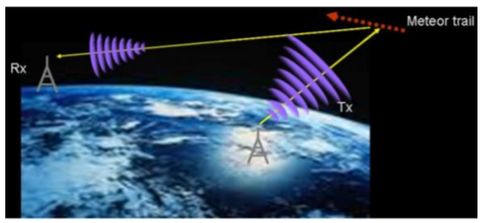
Aim

To detect the **Geminids** and their **characteristics** using equipment to receive radio waves at the **Marlborough College Blackett Observatory (MCBO)**. Characteristics include the **date** and **time** of the **peak** and the number of **events per hour**.

Introduction

The **GRAVES RADAR** in Dijon, France is a government-run, continuous wave radar which emits radio waves at a 143.050MHz frequency constantly. There are four transmitters at an upward angle of 25°, which each cover a sector of the 180° pointing South and upwards.

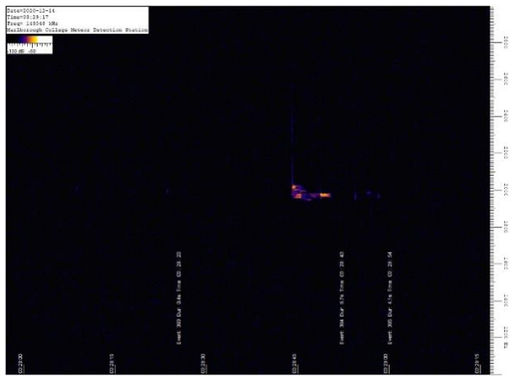
At the MCBO, **690km from GRAVES**, we have a 4 element YAGI aerial set up at a 16° angle of elevation which points to around halfway between it and GRAVES. When a meteor or small particle enters the ionosphere around **90-100km** above ground, it ablates and ionises the atoms creating **positive ions, electrons and neutral molecules** in the **plasma head** of the object and in the **ionisation trail**. The radio waves intercept both and the **electrons** re-radiate them which is received at the MCBO. The plasma head has a **short** but **strong** signal, the ionisation trail has a **long** but **weak** signal, and the overall strength of the signal depends on the **electron density** in both:



Method

The 4 element YAGI **aerial** is connected to a **FUNcube Pro+ Dongle** which is then connected to the **PC** at the observatory. The dongle is tuned to **143.048MHz** and the detection software (**Spectrum Lab**) is set to show events **1-3kHz** above that frequency, so the GRAVES reflections appear around **2kHz above**. This is the series of events which lead to displaying the showers on a graph:

- A significant event is detected and displayed on the computer:



- The **x-axis** shows **time**, and the **y-axis** shows **frequency**. The **volume** (in **dB**) of meteor is shown by its colour with a scale in the top left.
- **Blueshift** and **redshift** is shown by the lines going **up** and **down** respectively showing frequency increase and decrease. This meteor mostly moving towards us (blueshifted).
- The event must be **loud** enough and **long** enough to be added to the tally of events. This is then added to the heatmap showing the number of **events each hour**.
- This can then be converted to a bar chart showing events per hour.
- The detection program, shown above, is **constantly running and live**. This can be seen at www.blackettobservatory.org

Results

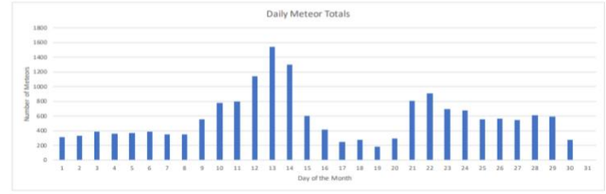
McBORIS - RMOB - DECEMBER 2020

Hour \ Day	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
0	18	9	16	9	18	15	12	15	16	49	31	24	50	88	22	23	7	17	9	-	34	28	29	22	25	16	23	15	20	22	-
1	17	8	23	14	13	20	10	15	12	29	32	30	66	103	27	25	14	11	15	-	29	48	21	31	23	24	25	26	19	29	-
2	16	13	19	16	18	13	20	11	13	34	36	43	69	123	26	23	6	19	11	-	41	51	28	33	18	18	25	33	30	28	-
3	19	15	25	12	14	18	22	20	21	34	37	51	84	102	31	37	14	6	14	-	33	48	46	43	33	30	23	40	32	48	-
4	22	19	17	22	19	16	11	19	24	46	42	39	81	97	34	25	10	12	18	-	43	55	32	53	34	31	31	28	33	33	-
5	12	14	22	12	19	13	21	18	23	35	33	56	86	94	33	26	6	19	15	-	51	63	43	51	20	30	28	35	24	29	-
6	20	12	24	15	13	15	12	14	17	40	34	45	69	95	28	36	10	14	18	-	48	45	28	27	25	30	20	26	24	36	-
7	16	8	17	14	12	15	10	20	14	22	32	43	76	74	30	29	11	12	15	-	30	37	26	36	22	23	27	23	28	31	-
8	14	8	18	13	16	15	18	15	14	24	37	39	74	61	39	25	12	18	8	-	25	48	23	45	27	30	22	21	30	23	-
9	7	12	18	18	15	20	16	9	12	21	37	45	49	37	17	23	10	14	9	-	27	46	29	36	22	28	26	32	23	-	-
10	11	17	13	18	18	15	11	14	13	26	32	39	40	35	20	12	9	10	12	-	25	49	30	36	30	21	25	25	30	-	-
11	11	11	17	11	15	20	16	13	17	25	18	32	27	24	21	15	13	13	15	-	53	29	29	31	35	19	25	31	35	-	-
12	12	12	12	17	14	18	19	13	22	27	28	31	29	26	31	12	8	11	7	-	34	47	31	35	27	31	24	32	34	-	-
13	8	14	17	11	11	13	10	14	26	24	21	21	37	22	18	12	14	15	14	31	35	36	33	35	27	23	23	28	33	-	-
14	6	-	8	10	19	14	10	11	27	28	14	22	14	23	19	5	8	6	7	-	21	24	25	26	33	19	22	25	32	23	-	-
15	8	16	13	18	15	24	17	13	24	20	25	28	30	14	11	5	8	14	-	-	20	35	28	34	23	11	15	15	20	20	-	-
16	5	11	16	17	11	14	12	10	32	18	14	19	32	18	10	6	11	8	-	-	30	29	27	19	12	12	22	24	17	16	-	-
17	10	18	5	14	10	8	10	15	25	23	14	26	32	17	19	11	14	8	-	-	29	30	23	29	17	20	14	14	11	20	-	-
18	10	25	20	12	15	23	16	10	28	36	37	42	51	27	18	5	8	7	-	-	38	31	28	27	13	18	23	20	24	18	-	-
19	22	18	14	19	14	15	19	18	35	33	45	80	76	22	30	12	9	9	-	-	22	37	34	28	8	19	27	26	21	24	-	-
20	22	23	14	16	18	11	22	10	35	57	53	80	96	49	28	14	13	13	-	-	32	23	39	22	28	17	24	20	19	19	-	-
21	7	8	13	15	18	17	13	15	40	51	61	102	124	61	38	13	18	7	-	-	28	25	31	27	8	19	20	25	20	24	-	-
22	13	19	15	21	20	22	8	22	39	45	46	129	138	51	25	9	7	4	-	-	27	22	16	24	15	23	16	12	27	24	-	-
23	5	17	15	16	11	17	11	18	21	35	36	71	110	31	29	13	10	9	-	-	19	39	26	29	12	28	24	15	20	13	-	-
DAILY TOTAL	311	327	391	360	366	391	346	352	550	782	795	1137	1540	1294	604	416	250	276	186	297	803	907	693	677	554	561	543	606	596	279	0

Marlborough College Blackett Observatory Reflected Ionisation System
4-Element 2m YAGI aerial
Funcube Pro + SDR Dongle
GRAVES: 143050 kHz
Spectrum Lab

Monthly Hour Maximum:	138
Monthly Hour Minimum:	4
Monthly Hour Mean:	25

System Changes:
10:00 on 16/12/20 - aerial removed from mast
17:00 on 17/12/20 - New bracket installed, back on mast
15:00 on 19/12/20 - Aerial moved outdoors
18:00 on 19/12/20 - System restarted with aerial outdoors
11:00 on 20/12/20 - System far too sensitive! Registering non-meteor events. Gain reduced, SNR threshold increased
12:00 on 20/12/20 - Sensitivity reduced further
13:00 on 20/12/20 - Sensitivity reduced again to acceptable level



Conclusion

Detecting the Geminids from the MCBO was successful as our data is very close to the data from NASA:

- The **peak** being between the **4-17th December**.
  - Our results show it on the **night of 13th**.
- The meteors per hour during the peak is **120**.
  - Our results show the highest being **138** at **2200** on 13th.

Our data also shows a smaller 2 hour peak on the night of the **12th** with 102 events at 2100, and 129 events at 2200. This too approximately matches NASA's data.

References

NASA. (2019). "Geminids". https://solarsystem.nasa.gov/asteroids-comets-and-meteors/meteors-and-meteorites/geminids/in-depth/
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